

Variability and Absence of Sexual Dimorphism in the Sounds of *Cycnia tenera* Hübner (Lepidoptera: Arctiidae)

JAMES H. FULLARD

DEPARTMENT OF BIOLOGY, CARLETON UNIVERSITY, OTTAWA, CANADA, K1S 5B6

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Abstract: The arctiid, *Cycnia tenera* Hübner exhibits no sexual dimorphism in six out of seven acoustic parameters measured in the sounds emitted by five male and five female specimens. The parameters reveal an extremely high level of variability for both male and female emissions. These observations suggest that calling or courtship signalling are not likely roles for the sounds of *C. tenera* but do not rule out the possibility of other intra-specific communicative functions.

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INTRODUCTION

Although it has been known since 1864 (Laboulbène) that certain arctiid moths will emit sounds, quantitative analyses of the emissions have been scarce (Rothschild and Haskell, 1966; Blest et al., 1963). It is now generally held that arctiid sounds serve a role in anti-predator defense (Dunning and Roeder, 1965; Dunning, 1968), but the possibility that the sounds operate as calling or courtship signals has never been seriously examined. Forbes and Franclemont (1957) noted the absence of sexual dimorphism in the external morphology of the sound-producing organs (tymbals) of a number of arctiid species but did not investigate the sounds produced by either male or female specimens.

Cycnia tenera Hübner is one of a number of Nearctic arctiids that will produce sounds under tactile or acoustic stimuli (Fullard and Fenton, in press). The tymbal of *C. tenera* possesses a well-defined row of microtymbals that is positioned on a ridge along the anterior edge of the sclerite. Fenton and Roeder (1974) present a comparative survey of some arctiid tymbals including those of *C. tenera*.

In this study, the sounds of male and female *C. tenera* were analyzed with reference to certain acoustic parameters to determine the degree of variability of the sounds and whether there were any differences due to sexual dimorphism.

METHODS AND MATERIALS

Specimens of *C. tenera* were collected from June 7 to July 17, 1975 from four ultraviolet light traps at the Queen's University Biology Station located

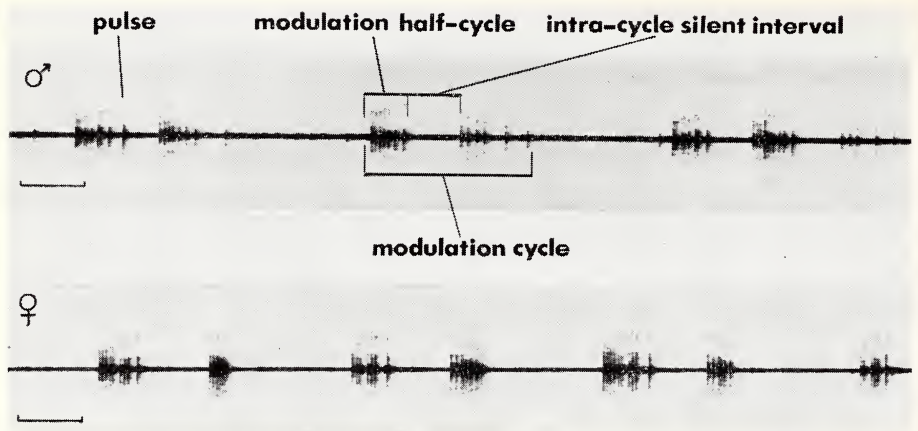


FIG. 1. Oscillographic traces of the emissions of male (top) and female (bottom) *C. tenera*. The acoustical parameters used in the study are illustrated for the male emission. Time scale for both oscillograms is 10 msec.

near Chaffey's Locks, Ontario, Canada. Moths were recorded immediately following capture. The specimens were placed individually 2 cm from a Brüel and Kjaer (B&K) $\frac{1}{4}$ -inch condenser microphone Type 4135 and stimulated to produce sounds by holding the moth's upraised wings between thumb and forefinger and lightly touching the insect's abdomen. It was possible, in this way, to obtain sustained emissions of up to 30 sec in length after the initial stimulus was applied. Sounds produced by moths restrained in this fashion appeared no different than those from specimens recorded in stationary flight with their wings free. The method employed in this study, however, did allow for greater accuracy of intensity measurements.

The signal was amplified by a B&K Measuring Amplifier Type 2606 and then fed into an Ampex Instrumentation Recorder (PR-500) using a tape speed of 76 cps. The signal was later analyzed by playing it back at reduced tape speed (2.4 cps) into a Tektronix 5103N Storage Oscilloscope.

The acoustic parameters measured in this study include ones previously described by Blest et al. (1963) and Dunning (1966, 1968) and are illustrated in Fig. 1. The following measurements were used: 1. duration (msec) of modulation half-cycle (MHC); 2. duration (msec) of intra-cycle silent interval (ICSI); 3. duration (msec) of modulation cycle (MC); 4. pulses per modulation half-cycle (P/MHC); 5. pulse repetition rate (pulses per second) (P/SEC); 6. dominant frequency (kHz) (DFREQ) and; 7. intensity (dB) (linear setting) (re .0002 dynes/cm²) (INT).

Intensities were measured at 2 cm using the B&K Measuring Amplifier and recorded as dB SPL (re .0002 dynes/cm²).

TABLE 1. Measurements of acoustic parameters in male and female *C. tenera*, coefficients of variation and results of single classification analysis of variance.

Parameter	Average Values		Coefficients of Variation		F _s -value ²
	male	female	male	female	
MHC (msec)	5.0 ± 1.3 ¹ (5)	5.5 ± 0.7 (5)	26.0	12.7	0.47
ICSI (msec)	6.2 ± 1.5 (5)	6.3 ± 2.2 (5)	24.2	34.9	0
MC (msec)	17.4 ± 2.1 (5)	19.7 ± 2.9 (5)	12.1	14.7	1.94
P/MHC	8.4 ± 2.4 (5)	6.9 ± 1.5 (5)	28.6	21.7	1.35
P/SEC	1677.9 ± 145.5 (5)	1316.3 ± 245.7 (5)	8.7	18.7	10.48 ³
DFREQ (kHz)	57.8 ± 18.9 (5)	48.2 ± 13.2 (5)	32.7	28.6	0.84
INT (dB)	69.8 ± 2.6 (5)	66.3 ± 5.7 (3)	3.7	8.6	1.47

¹ Mean ± S.D. of mean. Figures in parentheses indicate sample size.

² Probability = 5%.

³ Significant.

Dominant frequencies were determined from frequency spectra produced from continuous emissions played into a Tektronix Storage Oscilloscope Type 564 equipped with a Type 3L5 Frequency Spectrum Analyzer. The analyzer was calibrated before each run using an Exact Model 126 VCF/Sweep Signal Generator set at 50 kHz.

The sounds of five males and five females were analyzed with reference to these parameters. The average values for each parameter from ten complete modulation cycles of each specimen were then used in a single classification analysis of variance (Sokal and Rohlf, 1969) to determine any differences due to sex.

To test for signal variability in the aforementioned parameters, coefficients of variation were computed for the values of both male and female emissions.

RESULTS

The parametric measurements, coefficients of variation and F_s values for the male and female sounds are presented in Table 1. The results of the analysis of variance test reveal no differences in any of the parameters studied except for pulse repetition rates where males exhibited slightly higher rates than

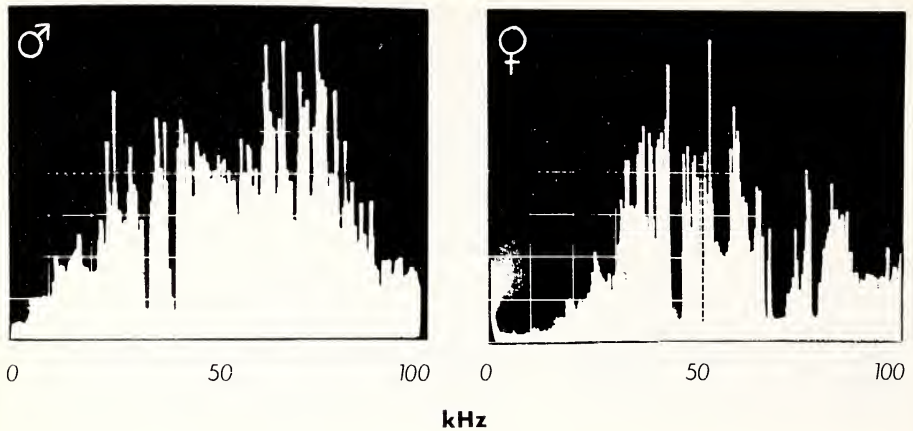


FIG. 2. Typical frequency spectra of continuous emissions of male (left) and female (right) *C. tenera*. Abscissa represents frequency in kHz and ordinate represents relative intensity.

females. There were no significant differences in the average intensities or dominant frequencies generated by either sex.

The coefficients of variation indicate an extremely high level of variability in all of the parameters surveyed for both male and female specimens. The highest values recorded were for DFREQ (male) and ICSI (female) and the lowest was for INT (male and female).

Typical frequency spectra from male and female moths are illustrated in Fig. 2. The frequencies emitted by the insects are almost completely ultrasonic and are broad-band with considerable energies contained in frequencies from 30 to 70 kHz. A small proportion of the frequencies generated is below 20 kHz (sonic) and renders the emission faintly audible to the unaided human ear as a soft buzzing sound.

DISCUSSION

The original assumption of Laboulbène (1864) that arctiid sounds were courtship signals seems unlikely in the case of *C. tenera*. Courtship songs in female arthropods are unknown (Alexander, 1967) and phonoresponses (i.e. "Agreement Songs" of Orthoptera (Dumortier, 1963)) are usually produced in response to male signals and differ in a number of ways (e.g. pulse-rate, intensity, duration) from the male stridulation. The existence of acoustically similar signals in both male and female *C. tenera* does not fit well with Dumortier's observations.

Several other factors also contradict a sexual role for the sounds of *C. tenera*. The emissions are generally low in intensity compared with other calling insects

(e.g. *Metrioptera sphagnorum* F. Walker (Orthoptera: Tettigoniidae): 87 dB(A) at 5 cm (Morris et al., 1975)) and would not function well as long-range calling signals. This, in itself, would not preclude the possibility that the sounds are used as short-range signals; however, the absence of sound-production in copulating pairs of other arctiid species (Dunning, 1966; personal observation) suggests that arctiids do not use their sounds in close proximity encounters.

The extremely high variability exhibited by the acoustic parameters of *C. tenera* emissions is also incongruous with a sexual function. In contrast, the male calling song of *Conocephalus nigropleurum* Bruner (Orthoptera: Tettigoniidae) possesses very low variability and this appears to be an important factor in eliciting a phonotactic response in receptive females (G. K. Morris, pers. comm.).

Although sexual signalling appears unlikely in the sounds of *C. tenera*, the possibility of other intraspecific communicative functions cannot be dismissed. If the arctiid sound is a warning signal for predators, the evolution of secondary responses in conspecifics (e.g. alarm reactions) would be reasonable to suppose. This, and other possible functions of the sounds are presently under investigation.

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